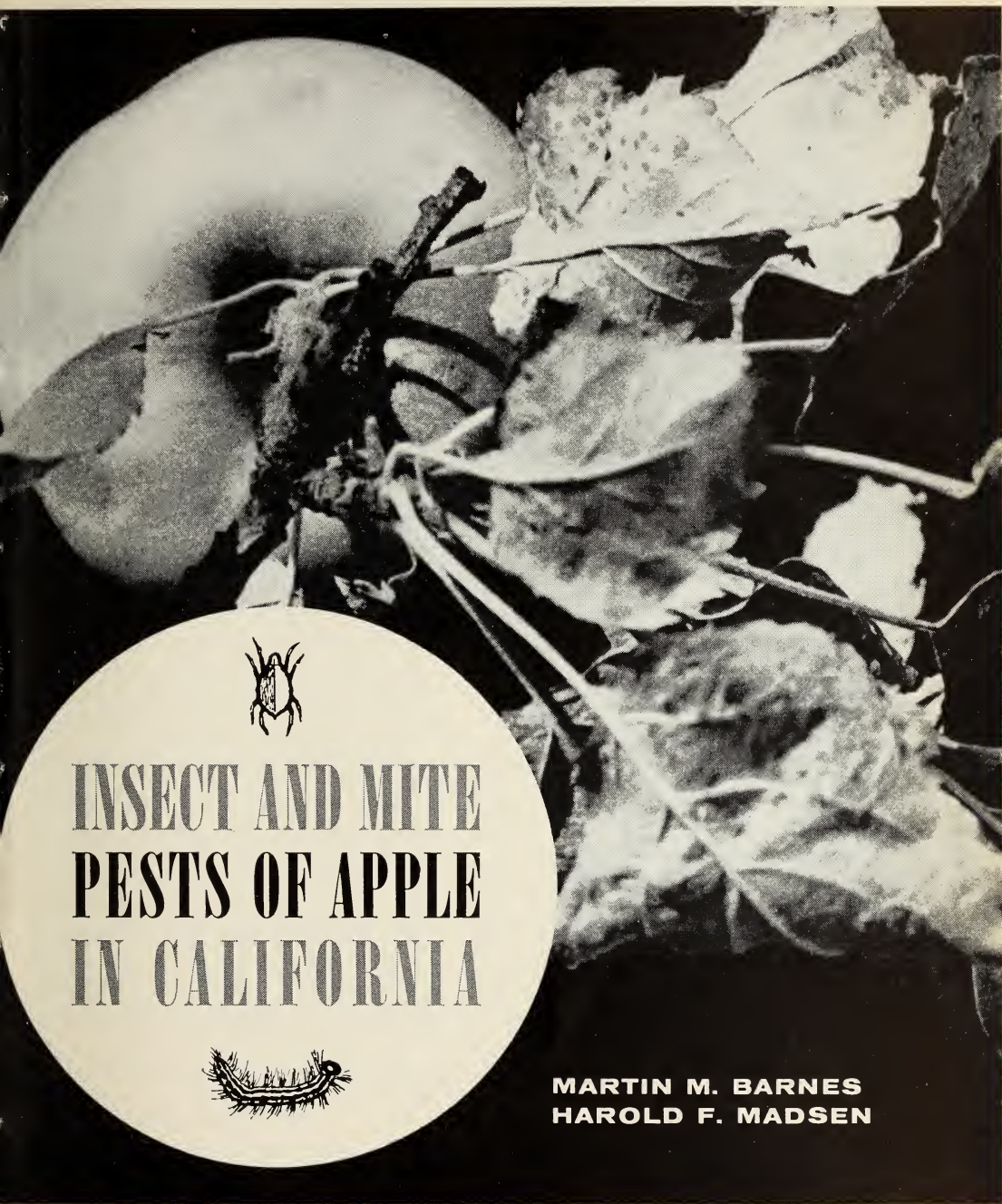




Division of Agricultural Sciences  
UNIVERSITY OF CALIFORNIA



**INSECT AND MITE  
PESTS OF APPLE  
IN CALIFORNIA**



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**CIRCULAR 502**

# *An Introduction to the Entomology of the Apple Orchard*

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The most important insect and mite pests of apple orchards in California are described in this circular. This account is for fruit growers, processors, field men, pesticide sales people, those in industry concerned with product research and development, as well as for entomologists less than expert on specific apple pests.

**Sound procedures** in insect and mite control in the apple orchard are based upon recognition of the pest and of the damage it causes, and upon a knowledge of its life history and habits. Several pests of apple trees are to be found in almost every orchard—the codling moth, the woolly apple aphid, and the green apple aphid, for example—while other pests vary somewhat more in their distribution over the state. All of them are subject to fluctuations from year to year in their severity as apple pests. Often the chief pest of the season in an apple orchard may have developed as a result of side-effects of the spraying program. Insecticides and acaricides are more or less specific in their effects, controlling one or perhaps several pests well, while controlling others less well or not at all. In apple orchards, predatory insects and mites and parasitic insects may be almost eliminated by necessary spray treatments, and with them goes a powerful influence upon levels of pest popula-

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tions. As a result of this circumstance and accompanying the change in insecticide usage a "new" pest may appear or a well-known species may flare up. Sometimes a high pest population may be related to the development of insecticide resistance, necessitating a change in the spray program. In other instances a pest outbreak may be related to seasonal variations over which there is no control. Whatever the case, it is desirable that the grower be able to recognize or readily identify the insect and mite pests with which he may be currently dealing.

Many insects and mites may require chemical control in apple orchards, but the principal species, the codling moth, is the perennial pest around which most of the pest control program is built. Other pest species may be equally destructive, and the indirect effects of foliage feeders on the quality and quantity of the crop must be recognized. Despite this potential for damage, all of these pests can be controlled.

**Care should be taken** that the chemical control of insects in the apple orchard does not result in inadequate pollination because of effects of insecticides on honey bees and other insect pollinators. Experiments have shown that most varieties of apples grown under California conditions are either unfruit-

ful or set unsatisfactory crops unless they are cross pollinated, and this may largely be accomplished by honey bees. Insecticides are not needed during bloom. Because of damage to nearby apiaries many insecticides should not be used when cover crops are in bloom, even in winter, unless proper precautions are taken. Other insecticides may be used around bees safely. Information may be obtained from the University of California Farm Advisor if there is a question concerning the use of insecticides around bees.

**The judicious use of insecticides**, avoiding unnecessary treatments and selecting the proper chemicals, has become an important part of practical horticulture. Specific suggestions on the use of insecticides are not given in this circular, however. The spraying program in apple orchards includes more than a knowledge of insects and mites and of insecticides and acaricides. The horticulturist recommends sprays for nutritional purposes, or for thinning or for prevention of harvest drop, while the plant pathologist recommends for control of diseases. The use of chemicals in the apple orchard is under constant development. Recommendations based upon latest information are prepared each year and are available at the local Farm Advisor's office.

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# Larvae attacking the fruit or foliage

## CODLING MOTH

"Codling" is an old English term for a kind of apple. The survival of this word in the name of the most important pest of apple trees is good evidence that this insect has been written about for hundreds of years, as indeed it has. The codling moth, *Carpocapsa pomonella* Linn., has the greatest potential for damage of any apple insect. Despite this, it can be satisfactorily controlled with a well planned spraying program. The codling moth also attacks pears, quinces and English walnuts and occasionally plums, apricots, peaches, nectarines and cherries.

### Appearance

The moths themselves are infrequently seen in the orchard, since they rest quietly on the bark during the day and are active only at dusk. Their recognition is useful, however, since they are readily caught in bait pans, a good way to detect

their activity. Wings folded, the moth is about  $\frac{3}{8}$  to  $\frac{1}{2}$  inch long, the wings when expanded extend to  $\frac{1}{2}$ – $\frac{3}{4}$  inch across. The forewings are a brown color crossed with predominant wavy gray bands. At the tip of each forewing is a coppery tinged dark brown band. This metallic tinged band serves readily to distinguish the codling moth from other moths found in the apple orchard.

The flat disc-like eggs are laid on the foliage and the fruit and are opaquely white when first laid. The eggs develop a red ring after 3–4 days at 70° F. Then, on the sixth day, the black head of the larva may be seen—the "black head" stage of egg development. Hatching takes place after seven or eight days when the temperature averages 70° F. Newly hatched larvae are white with black heads. Mature larvae are  $\frac{1}{2}$  to  $\frac{3}{4}$  inch long and are pinkish white with a mottled brown head.

### Injury

Damage is by larval entry into the fruit. The newly hatched larva may wander about on the foliage, but eventually it enters the fruit through the calyx end, the stem end or through the side of the apple. Fresh entries are identified by a light tan colored pile of frass. Appearance of many of these fresh entries is a readily detected sign of current larval activity and increasing damage. If the larva dies after penetrating a short distance, this results in a shallow injury called a "sting." More often the larva tunnels its way to the core where it feeds on the seeds and ruins the inside of the apple. When nearly full grown the larva works its way to the surface and begins to push frass out of the burrow, plugging the exit. When mature, it leaves the fruit through the exit hole in the side. An



A codling moth adult. Arrow points to copper coloring on tip of forewings.

open burrow is a sure sign that the larva has left the fruit. Evaluation of the total loss incurred must include fallen fruit, since wormy fruit falls to the ground prematurely, this being more pronounced with some apple varieties. Wormy fruit are cull fruit, unfit for shipment or for processing, a total loss to the grower and an expense to cull out.

### Seasonal development

The codling moth spends the winter as a full grown larva in a tough silk cocoon under the loose bark on the trunk and limbs, in tree crotches and similar sheltered places on the ground under the tree. Some larvae may still be in the fruit at harvest and are carried to the packing house where they spin their cocoons in boxes or in other places. This may result in a serious local infestation near the packing shed or near buildings where boxes are stored.

In mid-spring, the overwintering larva changes into a brown pupa and the first moths generally emerge in April or May, depending on the locality. The "overwintered brood" moths may continue to emerge and lay eggs over a period of about 8 or 9 weeks. Very generally speaking, moth emergence takes place at petal fall or shortly thereafter, but this varies widely. First emergence in the spring may best be determined by the use of bait pans as discussed in the section on control.

Moths are most active during periods with quiet warm evenings, mating and egg laying taking place at dusk. Egg laying may begin a day or two after the moths emerge, but moth activity is low and few eggs are laid if the temperature at dusk is below 60° F. More eggs are laid in the upper half of the tree than in the lower half. Eggs are laid singly usually on the upper side of the leaves and on the fruit, and hatching takes place in about 7 to 12 days depending on temperature. The newly hatched first brood larva wanders about in search of a suitable



Piles of frass around entries made by codling moth larvae attacking an apple.

place to enter the fruit and if hatched on a leaf, may feed slightly on the lower side. Entry into the fruit follows, frequently through the calyx end of the apple. When mature, after 3 to 4 weeks' feeding, the larva leaves the fruit and pupates in a sheltered place on the tree. These first brood pupae yield moths which produce the second brood of larvae. These moths are active from late June to August, depending on the season and the locality.

Most of the second brood larvae enter the side of the fruit and burrow into the core. When they mature, the great majority of the second brood larvae spin up in cocoons in sheltered places as previously described and spend the winter in the larval stage. If second brood development is early and control has been poor, a partial third brood may develop in late August or in September in some areas.

The codling moth is favored by warm weather and will be more difficult to control in years when warm dry weather prevails during periods of moth flight.

### Control

The codling moth may be controlled by a series of well chosen, properly timed, and well applied insecticide treatments.

Natural agencies, e.g., woodpeckers, predacious insects, diseases, etc., may take their toll, but in apple orchards this does not provide sufficient control and insecticide applications are necessary.

One rather important factor in successful codling moth control is worth considerable attention by apple growers. Most failures to control codling moth are the result of failures with the first brood. If the first brood is thoroughly controlled, the problem of controlling a later brood will be greatly diminished and severe late season losses will not be sustained. Thorough destruction of the first brood should be an important object of investments in codling moth control.

Timing of the first codling moth spray has frequently been related to petal fall. Intensive use of effective sprays with long residual action greatly lowers the codling moth population. Under these conditions, timing the first spray about 7-10 days after petal fall may be successful. However, it should be remembered that in some seasons the petal fall period may be extended over a considerable period of time, and of course, different varieties blossom at different times. Codling moth emergence is therefore not necessarily related strictly to "petal fall." The first codling moth spray may be timed instead by the use of several bait pans at different locations in the orchard, particularly where noticeable infestation has previously occurred. Properly used, bait pans will detect early moth activity, and the first spray treatment should be started soon after this activity is detected in the post-bloom period. Greater efficiency will result from this and subsequent treatments.

An attractive bait may be prepared from 1 part molasses and 9 parts of water or from 1 part Diamalt to 19 parts of water. A small amount of yeast may be added to encourage fermentation. These solutions become attractive after fermentation is under way. The bait mixture should be placed in an enamel pan about

3-4 inches deep and about 1-2 quarts in capacity, and hung by a rope through a pulley or screw eye in the upper third of the tree. Four or five pans should be enough if well placed. More than one series of pans should be operated if orchards are not adjacent. Water should be added to replace that lost from evaporation and pans should be refilled with fresh material about every 7 to 10 days. They should be checked every day or two for codling moths, and the insects cleared off the surface with a piece of screen. The date and number of codling moths caught in each pan should be recorded. It is desirable to install the bait pans during full bloom.

*The first codling moth spray should be completed within 10 days after the first moth is caught during the post-bloom period.* Spacing of later sprays must be in accordance with current recommendations. These may change according to the material used.

When first brood sprays are completed, there may be an interval before moths emerge for second brood egg laying. It is important to observe when these moths begin to fly. Here again, bait pans may be used to detect such moth activity. If moths are caught, these are from survivors of first brood control applications, and one or more second brood treatments may be required. These moths will become active sometime during the period from late June to mid-August, depending on the locality.

In districts where second brood activity occurs in late June and early July and where control has not been satisfactory, an additional treatment may be necessary against third brood in late August or September. Bait pans are again indicated to detect moth activity during this period.

Many insecticides are effective against the moth itself as well as against the eggs and newly hatched larvae. Control of the moth stage is an important part of present day control of the codling moth with insecticides, but residual protection against



newly hatched larvae is also needed and can be provided.

Failure to control codling moth can most frequently be traced to one of two factors: 1) poor control of the first brood because the first codling moth spray was applied too early or too late, or subsequent sprays too far apart, leading to an unexpectedly large and prolonged second brood attack or 2) development of insecticide resistance. The latter circumstance calls for a change in insecticides, but inadequate control of first brood because of improper timing or poor application practice is a more frequent cause of failure. Its remedy is to time the first codling moth spray by bait pans and to maintain the currently recommended interval between sprays. In orchards with heavy infestations carrying over from the previous year, this interval may be shortened by about one third, applying an extra spray against first brood.

By concentrating on first brood control year after year, this generation can be so effectively reduced that there may be no need to spray for second brood.

## ORANGE TORTRIX

Although known to occur in California for 75 years, the orange tortrix, *Argyrotaenia citrana* (Fernald), has been identified as a pest of deciduous fruits only since 1947. Published records prior to 1947 refer to damage by the apple skin worm, *Argyrotaenia franciscana* (Wlsh.), but it is possible that the insect involved was the orange tortrix.

The orange tortrix is currently a sporadic pest in the apple orchards of California's coastal counties, causing considerable damage in some seasons. Its increase as an apple pest has been related to the substitution of DDT for lead arsenate in codling moth control. The larvae are susceptible to lead arsenate, but not to DDT. Additionally, DDT may have adversely affected biological control of this insect. The orange tortrix also

attacks prunes, apricots and pears as well as citrus.

## Appearance

The moths are about  $\frac{1}{2}$  inch long and the forewings are tan to rusty brown in color and fold flat over the body in the shape of a bell. Also, when the wings are folded, the black diagonal bands across the forewings form a chevron or V-shaped band and there is a small dark triangular area near the outer margin below the arms of the V. The eggs are oval and flat and are laid in masses of 10 to 40, overlapping each other like shingles. They are cream-colored, turning yellow as they mature. The full-grown larvae are about  $\frac{1}{2}$  inch long and are straw colored or light green with a light brown head and thoracic plate. They are rather active and quickly wriggle backwards when disturbed, dropping to the ground or spinning down on a silken thread. The light to dark brown pupae are less than  $\frac{1}{2}$  inch in length, often being found in folded leaves.

## Injury

The larvae are leaf rollers and nest makers. They are solitary and are found



An orange tortrix moth.



Fruit injury caused by larvae of the orange tortrix.

rolled in a green leaf, or within irregular clusters of dried leaves attached to green leaves, twigs or fruits. Though considerable leaf injury may result from their feeding, the principal damage is by feeding on sound fruit. The larvae usually feed on the surface of the fruit, producing shallow, irregular scars, but may feed on the pulp of the fruit or even enter the core of open calyx varieties. Frequently they feed at the point of contact of clustering fruit. The Yellow Newtown variety is especially susceptible to orange tortrix because of the short fruit stem and the tendency for the fruits to touch.

### Seasonal development

An overlapping of generations occurs and although all stages may be found at any time of year, overwintering occurs predominantly in the larval stage. Larvae are usually found in winter in their nests of dried leaves webbed together against the bark, on which they may feed. If "aphid apples," or small spray thinned apples or mummified fruit remain on the tree during winter, larvae of the orange

tortrix will frequently be found feeding upon these. There may be two to four generations each year depending on the locality. The generations overlap, and the population mounts as the season proceeds. Severe damage may occur during late July and August. The egg masses are usually found on the smooth bark or on the leaves and occasionally on the fruit. Heavily infested orchards will experience fruit damage beginning in the postpetal fall period in May.

### Control

Timing of treatments for codling moth control will serve to control orange tortrix, special applications not being necessary. Since orange tortrix is not susceptible to some insecticides which control codling moth, notably DDT, a material must be substituted which will control both of these pests. If the infestation is light, attention must be given to orange tortrix control only in the second and third codling moth sprays. If a heavy population of the orange tortrix carries over from the previous year, it will be necessary to use a material effective on both orange tortrix and codling moth in all the codling moth sprays.

### FRUIT TREE LEAF ROLLER

The fruit tree leaf roller, *Archips argyrospila* (Walker), is an old pest of deciduous fruit trees. It is readily controlled by insecticides currently applied for codling moth and usually occurs in numbers on apple trees only where adjacent untreated hosts develop populations which spread into orchards. In addition to nearly all kinds of deciduous fruits, the fruit tree leaf roller attacks many deciduous ornamental and forest trees, certain bush fruits, and citrus.

### Appearance

The adult moth is about  $\frac{1}{2}$  inch in length and is bell shaped with wings folded. The forewings are mottled with shades of brown and yellowish white and have two creamy spots on the outer mar-



gin. The eggs are laid in masses covered by a gray cement and are found on the smaller branches and twigs. The gray cement becomes perforated as the 50 or more larvae emerge through it upon hatching. Newly hatched larvae are apple green with a black head and thoracic shield. When they are about half grown the head capsule is brown and the thoracic shield is tan to olive green with a darker lateral band on the margin. The larvae wriggle backwards when disturbed and often drop on a silken thread. The pupae are ordinarily found within folded leaves.

### Injury

The larvae roll the young leaves, feeding initially on the foliage and causing a “ragging” of the terminal growth. They tie leaves and blossom parts together and destroy blossoms and young fruits by eating the stems and newly formed fruits. They gouge deeply in the small fruits causing these to fall to the ground. Less severely damaged fruit remain on the tree and at harvest they will bear bronze colored scars which are characteristically deep and have a roughened surface. Such deeply scarred fruit are of little value.

### Seasonal development

The fruit tree leaf roller has one generation a year and overwinters in the egg



A fruit tree leaf roller moth. The photo shows the moth enlarged to approximately six times normal size.

Photo below shows injury to apple fruits caused by larvae of the fruit tree leaf roller.



stage in egg masses on the twigs and small limbs. Hatching occurs from green tip through the pink stage of the fruit buds. The larvae become full grown in about a month, pupate within folded leaves, and the moths emerge in May and June. They are frequently caught in codling moth bait pans. The eggs are laid at dusk primarily during June and do not hatch until the following spring.

### Control

This insect has been very well controlled by sprays applied for the codling moth. Where adjacent woodlands or untreated host trees develop large numbers of leaf roller moths, these moths may lay significant numbers of egg masses in orchards. Evidence of a high population of leaf roller larvae in early spring would indicate that application of the first post-bloom spray should begin sharply at petal fall, before significant fruit injury by leaf roller larvae can take place.

### EYE-SPOTTED BUD MOTH

The eye-spotted bud moth, *Spilonota ocellana* (D. & S.), though primarily a

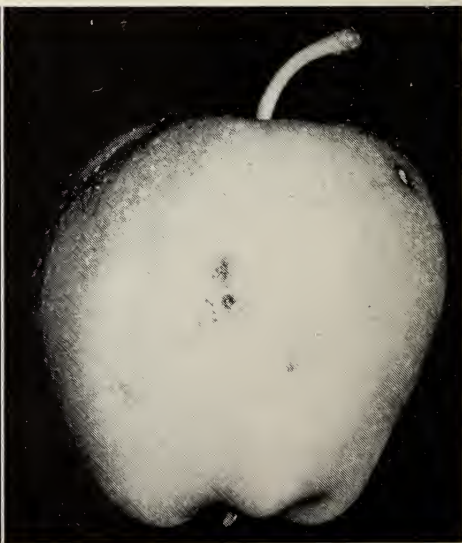
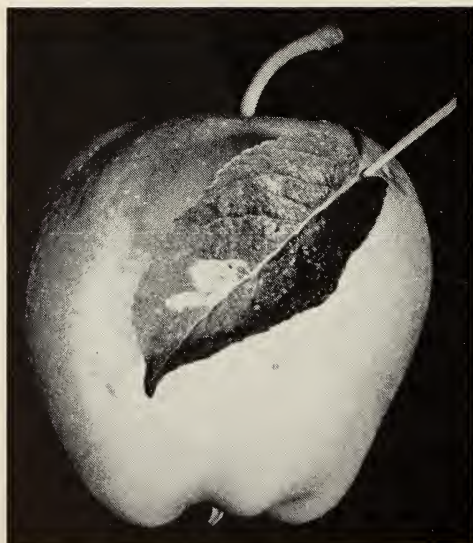
pest of prunes and plums in California, is better known as a pest of apples elsewhere. Cherries and pears may also be infested.

### Appearance

Adult moths have a wing expanse of  $\frac{1}{2}$  inch and are gray with a wide white band across the forewings. The eggs are laid on the lower surface of the leaf and are small transparent discs. The larvae usually feed under a protective layer of webbing which is rebuilt to cover new feeding areas. The mature larva is  $\frac{1}{2}$  inch long and is brown with a shiny black head, thoracic shield and anal shield.

### Injury

The overwintered larvae eat into the young fruit buds in early spring. Later, the larvae web the leaves together and feed on foliage, blossoms, and small fruit. In summer, newly hatched larvae begin to feed under webs on the under sides of the leaves. Their feeding results in brownish-colored areas partially skeletonizing the leaf. Infested leaves are often drawn against the fruit and firmly attached to it with webbing. This



Eye-spotted bud moth larvae feed on lower side of the leaf, sometimes attaching leaf to fruit. Photo on right shows fruit injury with leaf removed.



affects normal coloration of the fruit. The larva will then eat several small round holes through the skin of the apple. A large proportion of fruits may be injured in severe infestations.

### Seasonal development

The larvae hibernate in small cocoons in crotches of the buds and twigs. They begin to feed on the buds about green tip and complete their feeding on leaves, blossoms and fruits in May or early June, pupating in the "nests." Moths emerge in June or early July and deposit their milky white disc-like eggs on the lower surface of the leaf. Eggs hatch in about a week and the larvae feed on the under side of the leaves, tying these to the fruits and continuing fruit damage from July through September when they enter hibernation.

### Control

Overwintering bud-moth larvae can be controlled with dormant sprays, but application of an effective insecticide at pink bud or, in heavy infestations, at green tip is the more common practice. Larvae of the next generation feed and cause damage to fruit in summer, and treatments may be required in July. Applications should be made when the first fruit damage (tying of leaves against the fruit) is noticed.

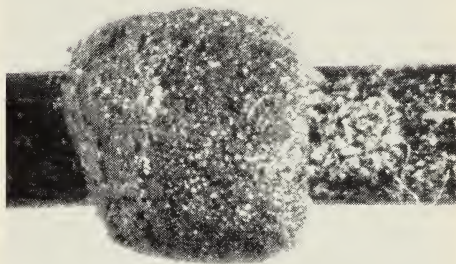
## MISCELLANEOUS CATERPILLARS

Trees which do not receive insecticide treatments in early spring may occasionally be infested with yellow-necked caterpillars, *Datana ministra* (Drury), tent caterpillars *Malacosoma* spp., larvae of the western tussock moth, *Hemerocampa vetusta* (Bdv.), or cankerworms, *Paleacrita vernata* (Peck), or *Alsophila pometaria* (Harris).

**Yellow-necked caterpillar moths** emerge from the soil in spring and lay white ovate eggs in masses on the under leaf surface. The gregarious larvae are



A yellow-necked caterpillar.



Typical egg mass of tent caterpillars.



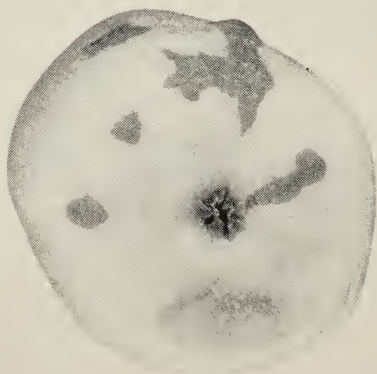
A tent caterpillar colony. Note defoliation of adjacent twig.





A horned caterpillar—larva of the western tussock moth.

voracious feeders and are 2 inches long when mature. They are dark brown to black with four yellow stripes on each side and long silky white hairs.



Characteristic feeding scars of the tussock moth larvae (horned caterpillar) on apple fruit.

**Tent caterpillars** emerge in early spring from egg masses which are cemented in a ring around the twigs, and they may strip the trees of leaves and fruit. The larvae are brown with a blue line on each side or with numerous yellow-brown stripes and a row of white spots along the back. They are gregarious and may construct tents of webbing.

**Tussock moth larvae**, or horned caterpillars, hatch in early spring from overwintering eggs on the limbs. They are brilliantly colored and bear white and black tufts of hair. They feed on leaves and scar the fruit.

**Cankerworm larvae** are green "measuring worms" about an inch long when fully grown, with stripes of yellow or green down each side and with 2 or 3 pairs of abdominal legs.

These caterpillars may be readily controlled by applying the proper insecticide, usually at pink stage or at petal fall. They are rarely found in well sprayed orchards.

# Aphids on apple trees

## WOOLLY APPLE APHID

The woolly apple aphid, *Eriosoma lanigerum* (Haus.), is a pest of major importance, especially in the coastal counties. This insect infests the roots, trunk, limbs, twigs, shoots and, on some varieties, the fruit of apple trees. It may occasionally be found on pyracantha, hawthorn and pear. It does not establish on American elm in California as it does in the eastern states.

The most important parasite of this aphid is a small wasp which, together with other beneficial insects, can greatly reduce woolly aphid populations. For many years, these aphid parasites and predators have been annually reduced during spring and summer by the repeated sprays which are required for control of other orchard pests. Unavoidably, this has resulted in greater dependence by the orchardist on insecticide treatment for adequate control of woolly apple aphid during this period. Even so, these beneficial insects should not be "written off" in considering woolly apple aphid control. Parasitization may greatly increase in the fall after the summer spraying is over, almost completely cleaning up woolly aphid colonies on the aerial portion of the tree. This tends to call attention to the already apparent desirability of avoiding unnecessary sprays.

### Appearance

The reddish to purple bodies of these bark feeding aphids are completely covered by masses of white wool-like waxy material in which balls of honeydew produced by the aphid are found. Aerial colonies of these aphids, festooned with white masses, are found on the twigs, limbs and trunks. Infestation on new growth frequently begins near the axils



Woolly apple aphid colony on a twig.



Galls formed by woolly apple aphid on apple tree trunk.



of the leaves. Infested twigs are swollen and knotted from gall formations at the feeding sites of the aphids. Limbs and trunks also harbor infestations, which result in gall formation, especially in pruning wounds or other injuries. Though not known to be present in California, the perennial canker disease of apple tree limbs and trunks is spread by the woolly aphid. Colonies on the roots result in extensive root deformation and the root becomes covered by a swollen, nodular, useless mass of gall tissue. Roots are more extensively infested in heavy clay soils which crack on drying, per-

mitting access to aphids. Root infestations are less extensive in sandy soils.

## Injury

This aphid infests all parts of the tree; heavy infestation results in severe retardation of growth and may stunt and kill young trees. The aphid produces honeydew which drips to the fruit and foliage, and a black fungus develops in these deposits, lowering the grade of the fruit. Heavily infested spurs may lose their leaves. Effects on growth of mature trees from heavily infested roots are not known, but these may be considerable in

## For better identification . . .

of certain pests that attack apples the photos below are shown in natural color—their color being almost the only distinguishing feature. These pests and the damage they cause are described elsewhere in the circular.



Upper left photo shows European red mites on damaged apple leaf. Note long white spines arising from white dots (see page 24). Upper right—two-spotted spider mite, nymph and adults (see page 26). Lower left photo shows brown mites, flattened on top, with long forelegs (page 29). Lower right—injury to apple leaves by brown mite.





Woolly apple aphid galls on apple tree root.

cases of extensive root galling known to retard growth of young trees.

Woolly aphids commonly infest the core of Yellow Newtown apples. This variety develops a high percentage of fruits with open calyx ends, especially in the Watsonville district. Aphids infest the cores through this open channel and establish colonies inside the apple. This creates difficulty in avoiding contamination by insect parts in processed apple products and is a serious problem to the canning industry. Under environmental conditions at Sebastopol, Yellow Newtowns seldom develop an open calyx end. Core infestations may also be found on other varieties of apple, e.g. Red Delicious, but the consequences are not so serious in the case of varieties which are not processed.

### Seasonal development

This aphid is found in colonies on the aerial portions of the tree and on the roots during the winter. Aerial colonies produce very little "wool" during this period and are not conspicuous. Large numbers of nymphs are produced by both aerial and root colonies beginning in early summer and continuing into the fall. These nymphs migrate to other parts of the tree and there is a stream of newly

hatched nymphs heading up or down the trunk of infested trees during summer and fall. Aphids from root colonies move to the aerial parts of the tree and those from aerial colonies move to the roots. The period during which the largest number of nymphs are in movement up and down the trunk is from mid-June to mid-September. As previously noted, the woolly apple aphid does not establish on American elm in California and in the absence of this alternate host relationship, spread of the aphid is apparently related to movement through the soil and by wind and other natural agencies.

### Control

Control of aerial colonies is complicated by the continuous dispersal of aphids from the roots, especially during summer. Even though complete control of the aerial forms is obtained, large new colonies may develop in less than 30 days. Chemicals which not only give high initial kill, but also provide a residual effect by preventing upward movement through toxic residues on the tree trunk, will be found most satisfactory.

The infested core problem has been shown to be associated with two factors: high woolly aphid populations, and conditions which favor the development of open calyx ends in the fruit. Since aphids rarely are found in the core when aphid populations are low, this suggests that core infestation is accidental, occurring as it does only when large numbers of nymphs are produced. In some years a much lower proportion of fruits develop open calyx ends than in other years. Especially where a core aphid problem exists, the critical period for control by spraying is in the months of July and August. Summer control should begin with a treatment about July 1, and a second treatment a month later is generally required. The spray should wet the trunks.

Some dormant sprays applied primarily for other pests, e.g. rosy apple aphid, may greatly reduce any overwintering

aerial woolly aphid colonies present and delay the development of high aerial populations, but summer sprays as described above will also be needed because of reinfestation from root colonies.

Some fourteen rootstocks resistant to woolly apple aphid have been developed in England and these are called the Malling-Merton rootstocks. At the present time little information is available concerning horticultural characteristics of these rootstocks under California conditions and their use should be considered experimental.

### ROSY APPLE APHID

The rosy apple aphid, *Anuraphis roseus* Baker, is potentially the most damaging aphid species on apples. It varies greatly in abundance from year to year and in some seasons may result in a distinct reduction in marketable crop. Before the development of effective insecticide treatments, crop loss from the rosy apple aphid occurred with greater regularity. If the rosy apple aphid is not controlled by dormant treatments, growers must look carefully for their presence

during the petal fall period and apply corrective measures before severe fruit damage occurs.

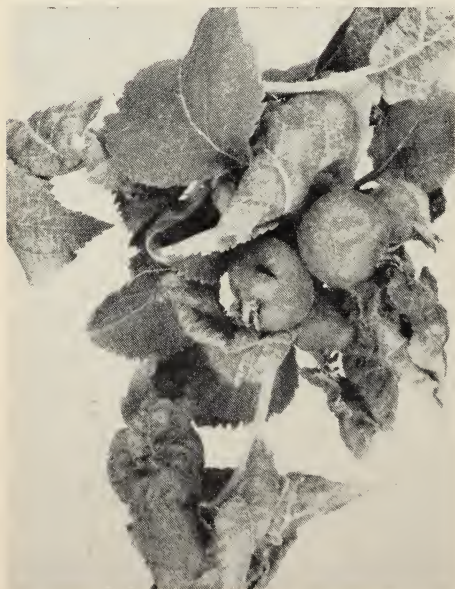
### Appearance

Overwintering eggs are about  $\frac{1}{32}$  inch long and are ovate in shape. They are light green when first laid but later become very dark green to black. They are very shiny and are found attached to the bark of twigs and branches on all parts of the tree. They may be hidden away in cracks in the bark or in bud axils.

Newly hatched rosy apple aphids are found on the very young growth in early spring and are a dark green color. They may be distinguished by their long cornicles which are flanged at the tip. Mature rosy aphids clustering in curled leaves or on young fruits in spring are a purplish or rosy-brown color and are covered with a waxy, powdery bloom. Winged forms developing on apple trees in late spring are brownish-green. On the alternate host, plantain or ribgrass, yellowish green individuals are found during summer.

### Injury

Rosy apple aphids frequently cluster on the leaves of the fruit spurs where they cause severe leaf curling. A considerable amount of honeydew is also produced which drips to the foliage and fruit. However, the chief damage is to the young fruits themselves. Fruits on heavily infested fruit spurs fail to develop but remain in clusters on the tree until harvest as small misshapen "aphid apples," characteristically puckered around the calyx end. Clusters of these worthless dwarfed and deformed apples may often be found on the inner parts of the tree at harvest. Though rosy apple aphids are most often found on the lower and inner parts of the tree, they may distribute over the entire tree if the season is favorable. In such cases, loss of fruit is considerable.



Tightly curled leaves and stunted fruit—damage by rosy apple aphid.



## Seasonal development

Hatching of overwintered eggs occurs just as the buds swell and break in spring and during the period shortly thereafter. Newly hatched aphids are found on the outside of the swollen buds and on the new green tissue. These are all females and give rise to several generations of wingless aphids. Young fruit stems and adjoining leaves are soon crowded with aphids. Infested leaves become tightly curled and control is then more difficult. As new growth develops, the young leaves are rapidly invaded by the aphids, and the shoot takes on a twisted appearance.

Fortunately, the rosy apple aphid does not continue its feeding on apple trees all summer. In June, winged forms are developed and these migrate to plantain. In the fall, winged forms fly back to the apple trees where they give rise to sexual forms. These lay their eggs on the bark as described above, where they pass the winter.

## Control

Rosy apple aphid may be controlled by application of an ovicidal spray during the dormant period in January or delayed dormant in February. Since some of the overwintering eggs are in crevices and cracks in all parts of the tree this application must thoroughly wet the bark in order to destroy them.

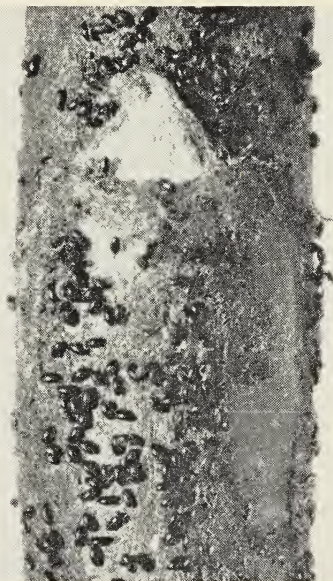
If thorough control of this aphid has not been obtained by application of a dormant spray, a well selected aphicide should be applied at the pink stage or soon after bloom, before extensive infestations of the fruit spurs develop. Not all aphicides can penetrate the tightly curled leaves, hence the selection should be made from recommended materials for this purpose. Control directed against the overwintering eggs is preferred to foliage sprays because it is generally easier and less costly to apply control materials during the delayed dormant or dormant period.

## APPLE APHID

The apple aphid, *Aphis pomi* DeGeer, often called the green apple aphid, is a frequently encountered pest of apples in California. It may also infest pear, quince, loquat, pyracantha and hawthorn. It is subject to wide fluctuations in abundance and in most areas it is a more commonly occurring pest of apples than the rosy aphid or woolly apple aphid. It infests succulent terminal growth primarily, and in heavy infestations it will also be found on the fruits.

## Appearance

Overwintering eggs are similar in appearance to rosy apple aphid eggs. They are most often found on twigs of the previous season's growth and especially on fruit spurs and water sprouts. Newly hatched apple aphids are a dark apple green color. Their short cylindrical cornicles distinguish them from newly hatched rosy aphids which are also green. Mature aphids on apple foliage in spring and summer are a bright yellowish green with the cornicles, legs and tips of the



These shiny black eggs are the overwintering stage of the apple aphid.





In addition to stunting new growth, the apple aphid produces large amounts of honeydew on which a sooty black fungus develops on foliage and fruit.

antennae black. Winged adults, which spread infestation to other trees, have a black head and thorax and a yellowish green abdomen with darker green lateral spots. In the late fall, small dusky, yellow wingless males and normal sized yellowish brown wingless females develop. The female lays the tiny oval overwintering eggs, in places described above, and these are yellow or green when first laid, turning a glossy black.

### **Injury**

Under favorable conditions, the apple aphid develops very high populations on apple trees. It is most abundant on succulent new growth and on young trees that are growing rapidly. On nursery stock and on young trees a heavy aphid infestation may seriously retard normal growth and result in irregular shoot growth, giving the young tree an abnormal appearance. On bearing trees,

heavy infestations of the aphid may cover the foliage and fruit with large quantities of honeydew on which a sooty black fungus soon develops, hindering normal leaf function. The black, sticky coating directly lowers the grade of the fruit. Prolonged infestation of young fruits will dwarf their development and produce a roughened, pitted surface.

### **Seasonal development**

Overwintering eggs hatch at bud burst. These are females and give rise to 10 or more generations annually. This aphid remains on apple throughout the season, but large numbers of them develop wings and migrate to other apple trees and other hosts. Initially, infestations may be more or less limited to tender, new growth, but as the population increases, the aphids move down the shoot to the older leaves. When the infestation becomes this heavy, damage to the fruit by

honeydew contamination becomes significant. In the coastal districts it remains as a pest through most of the summer. Populations become heavy in June and July and may decline in mid-August. Temperatures above 95° C. are very detrimental to populations of this aphid.

### Control

Infestations develop in summer regardless of whether an ovicide was applied during the dormant period or an aphicide is used at pre-pink or pink. Reinfestation is so general that summer treatments are usually necessary in the coastal counties. Extensive movement of winged aphids during spring and summer may result in rapid reinfestation and additional treatments are thus required. For corrective treatments in early summer, it is advantageous to use materials which provide systemic action in the new growth to overcome reinfestation by winged migrants and reduce the rate of subsequent development of colonies in the vicinity

of the fruit. Cool, moist conditions in the coastal counties favor the development of this aphid. Just as in the case of the woolly apple aphid, the critical period for control is during early July and early August. An application during the first part of July and again a month later is often required.

**NOTE:** The green aphid commonly found on apple trees in the spring in southern California is morphologically indistinguishable from the apple aphid. However, overwintering eggs have not been found on apple, and dormant ovicides are not suggested for control. This aphid is probably the spirea aphid (green citrus aphid) migrating to apple. Positive identification is not possible at the present time. Infestations of this aphid become prominent in some seasons during the post-bloom period, but they disappear with the onset of hot weather in late May or in June. Aphicides should be included with the first and second codling moth sprays, if required.

## Scale insects on the bark

### SAN JOSE SCALE

It appears that the San Jose scale, *Quadraspidiotus perniciosus* (Comstock), was formerly a more frequently encountered pest of apples than at present. Season-long use of DDT apparently has reduced the problem. Unless it is controlled, this insect can develop very heavy infestations on apple trees, killing entire limbs and marking the fruit. This scale insect attacks a very large number of host plants, including practically all deciduous fruit trees as well as many ornamental trees and shrubs.

### Appearance

The scale covering of the full grown female is round and about the size of a

pin head. It is gray in color with a nipple shaped spot at the center and centrally located yellow exuviae. The scale covering of immature forms is black. The body of the scale beneath the scale covering is yellow with two pairs of lobes. Male scales are elongate and smaller than the female.

### Injury

This well-known scale insect infests the bark, leaves and fruit of apple trees. Infested limbs decrease in vigor and if the infestation develops without control, twigs and limbs may be killed outright. A characteristic effect of infestation by this insect is a red stain beneath the bark where the scale is attached, especially on



San Jose scale on apple fruit.

young growth. Fruit infestation results in the development of a red spot on the fruit around each of the scales. Infestations of San Jose scale in orchards are frequently quite localized, perhaps involving a single tree, but the insect will spread through the orchard unless proper control measures are used.

### Seasonal development

The San Jose scale overwinters primarily in the black capped immature stages. These mature during early spring and the lemon yellow crawlers, which are born alive, are produced from May onward, more or less continuously through the season with generations overlapping. The crawlers may settle on almost any aerial part of the tree or may be carried to other trees by natural agencies.

### Control

Although scale infestations may ordinarily be held in check as a "side effect" of the use of DDT and certain other insecticides in repeated sprays for control of codling moth and other pests, infestations may arise in young orchards and occasionally in mature orchards calling for special applications for San Jose scale. These are ordinarily applied during the winter, when the scale is predominantly

in immature stages. Thorough coverage is necessary for satisfactory control. Development of scale infestations in the tops of trees is a clear indication of unsatisfactory summer spray coverage. Since the San Jose scale has a wide host range, trees and bushes adjacent to the orchard may be found harboring infestations. Where this occurs treatment or elimination is indicated.

## MISCELLANEOUS SCALE INSECTS

In well-kept apple orchards, the scale insects listed below are not often found in severe infestations. Where they occur, they are often kept under satisfactory control by spray programs directed against other pests, although special application may sometimes be required as noted in the following discussion.

**Parlatoria scale** or olive scale, *Parlatoria oleae* (Colvée), may be a problem on apple trees in the San Joaquin Valley and may occasionally require special treatment. This insect has a host range including over 200 plants and is a pest of several other deciduous fruit trees, notably peach, nectarine, plum and apricot. The full grown female scale has a scale covering which is ovate to circular in shape and is a dirty gray color with black exuviae.

The body of the scale varies from a light reddish color to dark purple. The eggs and crawlers are purplish in color. *Parlatoria* scale overwinters as an adult female. Egg production may be observed in late April and hatching of the crawlers usually begins in May. The crawlers wander about before settling on the twigs, limbs or fruit. A second generation of crawlers is produced in July. Foliage applications at the time the crawlers appear will effectively control this scale insect.

**Oyster shell scale**, *Lepidosaphes ulmi* (Linn.), resembles half a miniature oyster shell in shape and may encrust the limbs in large numbers. This reduces tree



vitality and yield. Limbs and entire trees may be killed. The scale covering is a light to dark brown color and in winter the pearly white overwintering eggs are found beneath. Hatching begins in June and lasts about three weeks. Best control results from sprays applied in early summer before a scale is formed over the settled crawlers.

**Italian pear scale**, *Epidaspis piricola* (Del Guer.), rarely is found on the fruit but may kill limbs and trees if heavy bark infestations are neglected. It

is seldom found in well-kept commercial plantings. This scale develops under coverings of moss on the trunk and limbs and can be found only if this moss is removed. The scale covering of the female is circular and dark gray with brown exuviae, and the scale body is reddish purple. The male scale covering is slender and white with yellow exuviae. It is readily controlled by dormant treatments which destroy the moss covering, as the scale does not survive without the protection of the moss.

## Borers on the trunks or limbs

### PACIFIC FLATHEADED BORER

The Pacific flatheaded borer, *Chrysobothris mali* Horn, is primarily a pest of small trees both in the nursery and orchard. Preventive action against this insect is important during the first three years after setting out a new apple orchard or replanting. This familiar insect also attacks many other kinds of orchard trees as well as ornamental and forest trees and shrubs.

#### Appearance

The adult is broad and flat,  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in length, with strongly toothed front legs. There are copper colored spots on the wing covers of this reddish bronze colored beetle. The full grown larva is pale yellow,  $\frac{1}{2}$  inch in length, with the body greatly enlarged and flattened just behind the head.

#### Injury

The larvae feed underneath the bark in and near the cambium, making shallow mines. If larval feeding is extensive the tree may be partially or completely girdled. Large numbers of young trees may be lost as a result of heavy flat-headed borer infestations.

#### Development

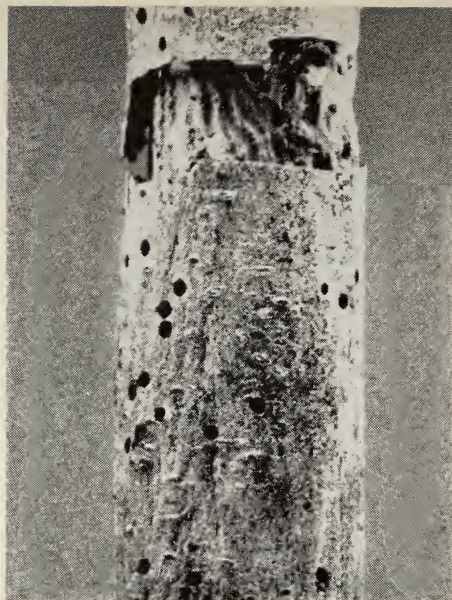
The adult beetles emerge and are active from April until August. They are attracted to weakened trees and will lay their eggs in cracks on bark exposed to the sun, especially on sunburned or otherwise injured parts of the trunk. The larvae bore into the bark and continue mining and feeding until winter, overwintering as larvae or pre-pupae in a cell in the hardwood. Pupation takes place from early to late spring.

#### Control

Young trees are most susceptible to attack. Trunks may be protected from beetle attack and from sunburn by repeated white washing or more surely by paper or cloth trunk protectors. Proper protection of the trunks of young trees will prevent severe losses from borers which may occur in new plantings and in orchards up to two and three years of age. Repeated applications of slurries of insecticide wettable powder are alternative to trunk protectors for borer control, but this will not prevent sunburn.

### SHOT-HOLE BORER

The shot-hole borer, *Scolytus rugulosus* (Ratz.), attacks weakened or dying



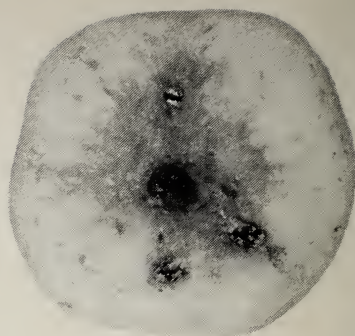
trees, especially those which are poorly irrigated, hence it is seldom a problem in healthy, well-kept orchards. It is most often a pest of stone fruit orchards but it will also attack apple and pear trees as well as ornamentals.

### Appearance

The adults are small robust beetles about  $\frac{1}{10}$  inch long and cylindrical in shape. They are dark brown or black with the legs, tips of the wing covers, and clubbed antennae a lighter brown or cinnamon red. The tiny legless larvae are white with brown heads and their bodies are slightly curved. Established infestations are readily recognized by the presence of numerous adult exit holes in the bark about  $\frac{1}{20}$  inch in diameter, hence "shot-hole borer."

### Injury

Shot-hole borer beetles feed at the base of the buds and they will attempt to enter the twigs and limbs to construct egg galleries. A healthy tree responds by profuse gumming. The beetles succeed in boring into weakened trees and lay eggs along short tunnels which they bore in the cambium. The larvae bore out at right



Shot hole borers injure the bark (left) and may also feed on and damage apple fruit (above).

angles to the tunnel and a heavy infestation will girdle and kill twigs and limbs. Light attacks weaken the tree for attack by later generations of beetles. On occasion, fruit will be attacked as a result of heavy beetle flights from a source of infested wood.

### Seasonal development

Adult beetles emerge through small round holes in the bark in late April or early May. They feed in buds in the leaf axils of new growth and bore into the bark to lay their eggs. The adults from this generation emerge in June. The life cycle of summer broods requires 3 to 4 weeks, and there are probably 3 or 4 generations each year. These overlap, and all stages of development may be present in late summer. They overwinter as larvae which may continue to feed during the winter, pupating in early spring.

### Control

As previously noted, healthy, vigorous, well-irrigated trees will resist the attacks of these beetles. If infestations succeed, infested limbs should be removed and burned during the winter. This prevents them from being a source of infestation the next spring.

Renewed attack may also be prevented



by well-timed use of an effective insecticide spray. Applications should be made when adult shot-hole borers are observed feeding on new buds in the leaf axils in

late April or in May, or later in the season if adult activity is noticeably high. Repeated use of DDT in the codling moth spray program is usually effective.

## Dimpled fruit or slit terminals

### MADRONE THRIPS

The madrone thrips, *Thrips madroni* Moulton, causes deep pits in fruits of Golden Delicious and Red Delicious fruits especially in the coastal apple district of Mendocino County. This thrips has a wide host range, occurring on madrone, manzanita, willow, ceanothus, toyon and other plants.

#### Appearance

The adult thrips is dark brown with a light band across the forewings.

#### Injury

Damage from this thrips results from its habit of inserting its eggs beneath the skin of young fruit. On the Golden Delicious and Red Delicious varieties this results in the formation of a raised scabbed spot surrounded by a circular depressed area. As the fruit grows, this area fails to develop and, at harvest these fruits are very deeply pitted or dimpled at the site of the egg puncture. As much as 10 per cent of the crop may be affected.

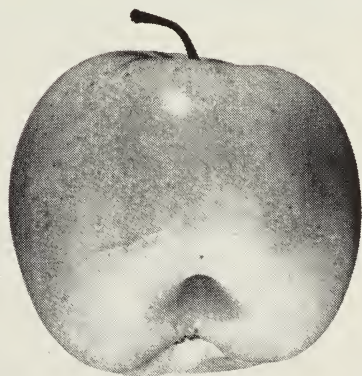
#### Seasonal development

Adult thrips may first be found in unopened blossoms as early as the pink stage, and their numbers increase in the blossoms during the entire period of bloom. From the pink period to bloom they lay their eggs in the flower parts, causing no noticeable injury. The damage apparently occurs during late bloom. When flower petals fold back and contact the surface of the fruitlet, thrips find pro-

tection beneath them and insert their eggs in the fruit. Injury continues until petal fall, when the thrips leave the apple tree.

#### Control

Perhaps the best timing of an application for control is during the pink bud stage. A residual insecticide should be used. This reduces the thrips population well before injury takes place during late bloom. A spray at full bloom might also be effective; however, this might well have a damaging effect on honey bees, depending on the choice of materials and whether the application was made when bees are not active, in early morning or in the evening. Treatments at petal fall or later are not effective.



Damage to Golden Delicious fruit by egg puncture of madrone thrips.

## BUFFALO TREEHOPPER

In areas where cultivation is generally practiced, the buffalo treehopper, *Stictocephala bupalus* (F.), is seldom a pest of apple trees. Where orchards or nurseries are adjacent to woodlands and undisturbed native cover, treehopper populations may be so large that young trees are severely injured by their egg laying activity. The eggs are laid in the young wood of many kinds of deciduous fruit trees as well as forest trees.

### Appearance and injury

The adult treehopper is a bright green insect about  $\frac{3}{8}$  inch long and rather triangular in outline, from above. The humped pronotum covers most of the body and bears stout, pointed horns at the front projecting laterally. The eggs are found in the bark of 2 to 3 year old wood of deciduous trees underneath double rows of curved slits; they are white, cylindrical, rounded on one end and tapered on the other. The nymphs, which are green with spiny outgrowths on the back, are found on grasses, weeds and cover crops.

The buffalo treehopper injures young apple trees by laying eggs in the twigs

and 2 to 3 year old wood. The female has a sharp ovipositor with which crescent shaped slits are cut in double rows and in which the eggs are inserted. These egg punctures may be so numerous that growth is impaired and twigs and branches may even be girdled and killed. Injury of this type is usually significant only on young trees and nursery stock.

### Seasonal development

The treehopper overwinters as an egg in the twigs of various "host" trees and the nymphs hatch in late spring. These drop to the ground and feed on grasses, weeds and various cover crop plants. They mature in the late summer, and in September and October cause damage to the young wood of apple trees by laying eggs in the bark.

### Control

Insecticide programs for control of this insect have not been developed. Clean cultivation prevents development of adult treehoppers inside the orchards, but they may move in from adjacent uncultivated areas. In the latter case there is no means of control that can be recommended at the present time.

## Grubs on the roots and Mites on the leaves

### PLEOCOMA

Larvae of beetles of the genus *Pleocomma* feed on roots of apple, pear and cherry trees. They are encountered relatively infrequently in orchards of California; however, they may cause significant damage to young fruit trees in Sierra foothills. Only when fairly large numbers of large larvae may be readily found is there much evidence of their feeding on the larger roots. The adults are large June beetles and the larvae are

large white C-shaped grubs. No method of control has been demonstrated.

### EUROPEAN RED MITE

Infestations of the European red mite, *Panonychus ulmi* (Koch), are of concern to the orchardist interested in high production of fruit of good size and quality. This mite is found on apple tree foliage from the late pink stage through September; failure to apply chemical control measures will often result in extremely





Pleocomma larva (right) and root damage it causes on apple trees.

high populations, seriously affecting normal functions of the leaves. Although a major pest elsewhere in the state, this mite does not occur in mountain apple orchards in southern California. The European mite is also an important pest of pears, plums, prunes, and walnuts and it may also attack peaches, cherries, almonds, and berries.

Apple varieties vary in resistance to mite injury. Varieties such as Standard or Red Delicious, Golden Delicious, Rome Beauty and Jonathan are rather susceptible to mite injury, while Gravensteins and Yellow Newtowns will show less evidence of leaf damage from moderately high mite populations.

### Appearance

The eggs are tiny, somewhat flattened globes, striate above with a stipe projecting from the top, and are a red to orange color. Winter eggs may be present in large numbers on the lower surface of twigs and small branches, and in cracks and crevices on the fruit spurs. Newly hatched mites are bright red, and

older stages are usually dark red with obvious whitish spots at the bases of the spines on the back. Some individuals may appear greenish or blackish. Nymphs are globular while adult females are elliptical in outline. Very little webbing is spun on the leaf surfaces.

### Injury

Mites feed upon the leaves, removing the cell contents and gradually give the leaf a finely mottled appearance, peppered with pale green. Heavy infestation results in severe bronzing of the foliage and some premature defoliation. Fruit remaining on heavily infested trees fail to size and color properly. Fruit production for the following year may be lowered. Under pressure of moderate to high populations, European red mites will lay a considerable number of eggs in the calyx depression area on the apple. In the canning process, these eggs cannot all be removed and may result in a high "insect part" count in the finished product.

### Seasonal development

Overwintered eggs hatch during the period from late pink to petal fall of the Delicious variety. If there is a heavy egg population, injury may occur to the first leaves in early season. Frequently, mite populations are light in early season and the mites are well dispersed over the entire tree. Since there are numerous generations each year, however, these populations increase steadily and by mid-season will become a severe problem unless chemical control measures have been applied. Periods of hot dry weather are very favorable for rapid mite development. The European red mite prefers the upper side of the leaf and a preferred place for the red summer eggs is along the leaf midrib. The European red mite lays its overwintering eggs on the lower side of the twigs and smaller limbs. This may occur as early as July in unchecked infestations when the leaves become ex-

hausted as a source of food. Usually this occurs in the fall, when the days grow shorter. When high populations are developed in mid-summer, a pronounced dispersal of the mites may occur. This is accomplished by air currents and new infestations may rapidly develop in previously treated trees immediately adjacent to heavily infested trees.

### Control

In the many orchards where this mite is annually a major pest, emphasis should be placed on the clear desirability of a preventive control program, i.e. a program based on annual control before mites reach damaging numbers. Control programs have been complicated by the fact that this mite has shown the capacity to develop resistance to organic phosphates and certain other acaricidal materials. The overwintering eggs are chiefly on the lower side and in cracks and crevices of the twigs and limbs, and it is not always possible to obtain sufficient control by dormant or delayed dormant ovicide treatments only. These serve to delay the development of damaging mite populations until summer, however. Currently, another period during which effective European red mite treatments may be applied in early season is during the pink stage. Control measures applied at this time or subsequently during the early season post-bloom period may succeed in preventing mid-season damage.

In many situations, use of acaricides along with the codling moth cover sprays may be required during summer to maintain control of European red mite and to control the two-spotted mite (see below). Good distribution of the spray over the entire tree is important in mite control and this is much more easily accomplished if the trees are kept well

pruned, permitting easy penetration of the spray blast into the inside and to the top of the tree.

### TWO-SPOTTED SPIDER MITE

Although present on apple foliage over a shorter period of the season than the European red mite, the two-spotted spider mite, *Tetranychus telarius* (Linn.), must also be considered a major apple pest. Populations of two-spotted mite tend to fluctuate from season to season, and in some years considerable defoliation may result in apple orchards. As noted above, apple varieties vary in susceptibility to mite attack. This mite also commonly infests other deciduous fruit and nut trees, many vegetable crops, berries, melons, cotton, and alfalfa as well as many weeds, flowering plants, shrubs and ornamental trees.

### Appearance

Adult female two-spotted mites are larger and more elongated than European red mites and are green to yellow in color. Feeding mites have a dark spot on either side of the body which may enlarge to cover most of the body. In contrast to the European red mite, these mites prefer the lower side of the leaves. The tiny, spherical, colorless to light straw-colored eggs are distributed over the infested area of the leaf and in the relatively extensive fine webbing produced by the mites. Overwintering females are orange and do not have spots.

### Injury

Injury is due entirely to leaf feeding, though it must be kept in mind that severe leaf injury by this mite will affect the size and quality of the fruit. Heavily infested leaves are finely mottled with pale green as a result of mite feeding, followed by bronzing and yellowing and early defoliation.

### Seasonal development

In deciduous fruit orchards this mite overwinters as an orange-colored female

COLOR PHOTOS of some of the pests described here appear on page 14.



under the bark scales and under refuse at the base of the tree. During mild winters, it may often be found in small numbers feeding on orchard cover crops or on weeds, especially in the coastal areas. In early spring, populations on cover crops and weeds develop first, and few if any mites will be found on the trees. Populations of this mite increase greatly in late spring and early summer, and infestation of apple trees is generally noticed in June or July. These mites are invariably first found on the lower side of leaves on the inside of the tree, having moved up the trunk to infest water sprouts and other inside foliage. Eventually they spread to all parts of the tree. Warm dry weather is very favorable to their development, and there are many generations each year. The orange overwintering females develop in September and October and seek hibernation quarters.

### Control

Frequent inspections during early summer should be made to determine if there has been any development of two-spotted spider mites on foliage on the inside of the tree. Treatments should be given before populations build up to high levels. It is important that the spray be well distributed over the tree, penetrating well to the inside of the tree. This is easier to do if the tree has been well pruned. It may be necessary to change to a different acaricide if this mite develops resistance.

Infestations may sometimes be traced to the drying up of a host cover crop or of orchard weeds, resulting in movement of the mites in search of other hosts, some crawling up the tree trunks and infesting the foliage. The mites will generally remain on a cover crop which is supplied with ample water through frequent irrigation. If experience shows that populations typically develop to a high level on the cover crop, followed by tree infestation, it will be found that a material degree of preventive control may be ob-

tained by directing early sprays to the cover crop. It has also been observed that elimination of certain favorite weed hosts, such as morning-glory, may result in reducing intensity of infestation of the trees.

### MCDANIEL SPIDER MITE

The McDaniel spider mite is a serious pest of deciduous fruit trees in localized areas in the Pacific Coast states. Heavy infestations of this mite may develop on apple trees at Oak Glen near Yucaipa in California. Besides apples, it also attacks plums, prunes and raspberries in other areas.

### Appearance

Adult female mites are of a greenish or yellowish color and when heavily feeding may have a large dark spot on each side and a pair of dark spots near the end of the body. Frequently in late summer, large numbers of these mites will have no definite spots, or spots that are



Greatly enlarged photo of McDaniel spider mites.



Leaf injury caused by McDaniel spider mites—upper and lower surfaces.

small and irregular in distribution. The mites prefer the lower side of the leaf but will move to the top in heavy infestations. They produce a fine, profuse webbing, and the clear to straw-colored eggs are found in the webbing or on the leaf surface. Overwintering females are a bright orange.

### Injury

The injury produced by feeding on the leaves is quite similar to that caused by the two-spotted spider mite, with foliage mottling followed by bronzing or yellowing and early leaf drop. In addition the leaf may become somewhat folded, and in the folds dense webbing, many mites and eggs will be found. Countless thousands of surplus females may be found on the trees at harvest, covering the calyx ends of the fruit with such fine webbing that they appear to be capped with cellophane.

### Seasonal development

In the spring and early summer, infestations of this mite are first encountered on the "water sprouts" of the trunk and main limbs of apple trees. Inside foliage is then attacked and the mites eventually spread to all parts of the tree. Populations increase very quickly in warm, dry weather and the foliage may be injured rapidly. Infestations usually become severe in late July and August.

The bright orange overwintering females develop in September and these move to sheltered places under the bark and on the ground.

### Control

Treatment is best applied before infestations have reached a high level. When infestations are high, the profuse webbing makes spray coverage difficult. Preventive control is easier than corrective control and the latter cannot correct for leaf damage which has already occurred. It is desirable to watch for increase in mites found on the water sprouts and other foliage inside the tree, since mite build-up tends to occur there first, though a light population may be more extensively present. Spray applications should be well distributed over the tree; this is easier if the tree has been properly pruned to permit penetration of the spray. This mite has developed resistance to certain acaricides. When this occurs, a change to a material with a different kind of toxicity is necessary.

### YELLOW SPIDER MITE

The yellow spider mite, *Eotetranychus carpini borealis* Ewing, occurs in California but is not a prominent pest of apples and pears as in the Pacific northwest.

### Appearance

The adult mites are very small and slender and are pale yellow or green with two or three pairs of small spots on the body. The eggs are spherical and clear with a fine dorsal stipe. The overwintering females are bright lemon-yellow.

### Injury

The mites infest the lower leaf surface along the midrib and veins, forming small colonies when not abundant. Feeding injury may resemble mildew spots.

### Seasonal development

This mite hibernates under the loose bark of the tree and its seasonal develop-



ment is similar to two-spotted spider mite except that it tends to be active later in the fall.

## BROWN MITE

The brown mite, *Bryobia arborea* (Morgan and Anderson), formerly known as the clover mite, is the principal mite pest of mountain apple orchards in southern California, but is only occasionally observed as a pest of apples in other areas of California. This mite is a frequent pest of almonds, peaches and plums, and it also infests pears.

### Appearance

The body of the adult mite is flat on top. The adult is larger than other mites found on apple and is rusty brown or dark green in color with amber-colored legs. It is readily distinguished from other mites on apple trees by the fact that the front legs extend forward and are very long, as long as the body. The egg is spherical and red. Summer eggs are laid on leaves and on twigs and spurs and are covered with small particles. Overwintering eggs may be found in large numbers on the lower sides of the twigs and smaller branches, and are also covered with dust-like particles. Newly hatched mites are bright red, turning brown or greenish after feeding. This mite does not spin webbing.

### Injury

Leaf injury is similar to that caused by the European red mite, the leaves becoming pale in color from the fine mottling which results from mite feeding. Intense mite damage to the leaves results in smaller fruit.

### Seasonal development

The brown mite overwinters in the egg stage on the twigs, branches, and smaller limbs. Hatching is well under way at the pink bud stage and there are several generations each year, the mites continuing to develop on apple trees until fall. In the fall, or earlier if heavy feeding exhausts

the food value of the foliage, the mites lay overwintering eggs.

Mites similar in appearance to brown mites may be found on orchard weeds and cover crops, but according to present information this closely related form does not move to the trees.

### Control

Where this mite is a consistent problem each year, it is desirable to use preventive treatments. Dormant sprays directed against the overwintering eggs have been used in the past but these may not provide seasonal control. A good time for preventive control sprays is during the pink bud stage. Thorough application of an effective material at this time will often control brown mites for the season. If pre-bloom sprays are omitted, an acaricide may be included with any of the codling moth sprays as corrective treatments.

## BLISTER MITE

The pear leaf blister mite, *Eriophyes pyri* (Pgst.), is widely distributed in California, commonly infests pear, and is sometimes found as a pest in apple orchards. However, apple trees with leaf blisters may be found near pear trees that have none and vice versa, suggesting the possibility of different races of mites on the two hosts.

### Appearance

These tiny mites are less than 1/100 inch long and are difficult to see without a hand lens or a microscope. The adults are white or pinkish with elongated tapering bodies and two pairs of legs. They are found under the bud scales during winter, and easily recognized leaf symptoms may be found in early spring.

### Injury

These mites form blisters on the lower sides of the leaves. At first these blisters are reddish or pale green, later turning brown. Heavily infested leaves may fall prematurely. Mites are found in large



Pear leaf blister mite injury on leaves and fruit.

numbers inside the blisters. Fruit may also be attacked resulting in blister-like lesions in early season and russeted and cracked areas on the fruit at harvest.

### Seasonal development

The mites spend the winter under the bud scales as adults. In late winter, prior to bud swell, eggs are laid which hatch before the buds open. As the bud scales separate in early spring, the overwintered adults feed upon the developing leaves and fruit within the bud. This feeding produces the typical blisters on the leaves and lesions on the fruit.

After the bloom period, mites may enter the leaf blisters through a small hole, and feed upon the leaf tissue from within this protection. Some mites may enter developing buds where they can remain during the summer. If a late flush of growth develops from an infested bud, blisters will again appear on the leaves. The mites return to the bud scales in August and September.

### Control

If infestations are severe enough to warrant treatment, control may be obtained with late fall or winter sprays directed against overwintering mites. If sprays are delayed to the green tip or pink bud stage, damage to fruit or foliage will have already occurred. Thus far, effective summer treatments have not been developed.

### APPLE RUST MITES

Of the two eriophyid species, the apple rust mite, *Vasates schlectendali* (Nal.), and Bailey's apple rust mite, *Calepitrimerus baileyi* K., the latter is the more common in California.

### Appearance, development and injury

These tiny, four-legged mites are white or pinkish white and are somewhat wedge-shaped, being broadest just behind the anterior end and tapering toward the rear. Both species are leaf vagrants, are

primarily found on the lower leaf surface, and are difficult to see with the unaided eye. They hibernate as winter females in bark crevices around lateral buds and under bud scales, moving to the leaves as these develop in the spring. High rust mite populations cause a browning of the leaf surface and the leaves take on a rusty, dry appearance. The edges of the leaves

may roll upward parallel to the midrib.

### Control

Satisfactory control for several weeks in early season results from delayed dormant or pre-pink sprays. These may be followed by including an acaricide effective against rust mites in one or more summer sprays.



# TOO MANY INSECTS . . . NOT ENOUGH INSECT-FIGHTERS



Students and instructor watch spray demonstration on Oxford Tract, Berkeley

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